BOOKS: HISTORY OF TECHNOLOGY

Edison—The View from Menlo Park

Bettyann Holtzmann Kevles

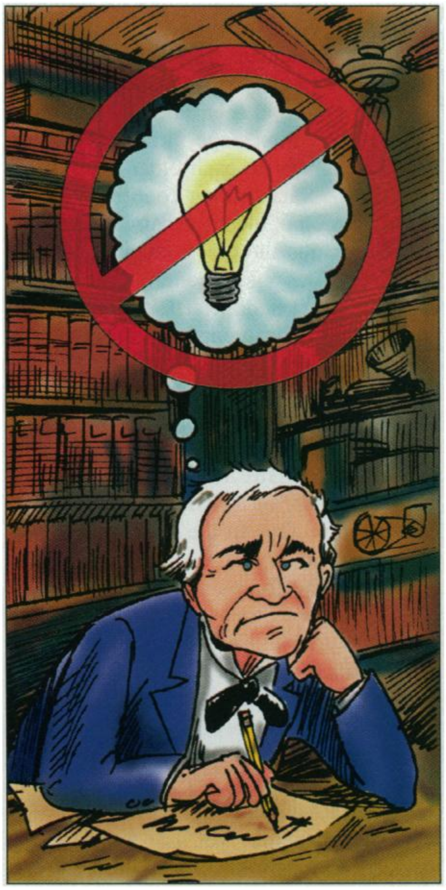
An incandescent light bulb above the cartoon inventor's head is a metaphor for "Eureka!"—the understanding that an idea for something new appears full-blown in a single mind. Indeed, this process of invention does occur; however, as Paul Israel illustrates in *Edison: A Life of Invention*, it did not for Thomas Edison. In 1986, Israel and Robert Freidel provided a very detailed account of Edison and electricity in *Edison's Electric Light: Biography of an Invention*. This time around Israel, who is also an editor of the multi-volume Edison papers, retells the story of the light bulb in the context of Edison's working style. As in the earlier book, there are reproductions of Edison's sketches and many details about the invention itself. But this book goes beyond the light bulb to consider Edison's experiences with a host of other inventions, including the phonograph, the fluoroscope, and motion pictures.

Edison
A Life of Invention
by Paul Israel
Wiley, New York, 1998. 552 pp. $30, C$42.50. ISBN 0-471-52942-7.

Undoubtedly, Edison was a genius. Yet according to Israel, this is as much for the way Edison systematically perfected each invention as for the inventions themselves. "As he invented a system of electric lighting," Israel explains, "Edison was simultaneously reinventing the system of invention." Israel suggests that the simplistic image of the cartoon inventor obscures Edison's real contribution to American technology. The image, he is quick to admit, is in large part Edison's fault, a result of the way Edison played the press to maintain interest in his products.

Moving chronologically through Edison's life, Israel demonstrates that although the inventor may not have had any formal education after age 14, he was not an uneducated lad, as he liked to be portrayed. Israel paints a vivid picture of mid-19th century "boy culture," including the not uncommon act of leaving home to travel the rails as a telegraph operator. Like today's computer-obsessed youngsters, boys like Edison reinforced each other's delight in experimentation.

Tracking Edison's ascent in the rapidly changing corporate world of the 19th century, Israel chronicles Edison's rise in wealth and social position. By the early 1880s, when Edison was in his mid-30s, he was already a legend, known as the "Wizard of Menlo Park" (after the site of his New Jersey estate). One of Israel's most interesting chapters covers the extent and nature of this fame. In 1886, the French writer Villiers de l'Isle-Adam published a novel about a fictional Edison, who creates an artificial man complete with built-in electrical gadgets. A decade later in the United States, a series of dime novels featured an adventurous, inventive, Tom Edison Jr. Edison apparently enjoyed the adulation. He was one of the first 20th-century celebrities, surrounded by journalists who hung on every word he delighted to provide.



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Paradoxically, as Edison's fame as an inventor was at its peak in 1901, the first Nobel Prizes were awarded for research in basic science. Not that Edison ignored scientific research. He hired mathematicians and Ph.D.'s in physics for his industrial laboratory, and his papers reveal that he understood a good deal of mathematics and physics. Nevertheless, Israel explains, Edison's laboratory was never really more than an overgrown workshop. Thus it was a bridge to, rather than a model for, the newer industrial laboratories established in the 20th century by General Electric, American Telegraph & Telephone, and DuPont. For Edison only used scientists to improve inventions that had grown out of practical knowledge (knowledge achieved through tinkering, rather than research); the newer labs asked researchers to explore basic science in order to develop technologies. As a result, in the decade before his death in 1932 Edison saw the mantle of wizard settle on men like Albert Einstein and Robert Millikan. Inventors like himself, although still respected, were again looked upon as ordinary people.

Other biographers have written about Edison's marriages, but Israel's account places his search for companionship in the context of his working ambitions. He married for the first time in 1871, when he was 24 and running a telegraphic news service in Newark, New Jersey. (One day in December 1870 Mary Stilwell, a 16-year-old employee, turned to him and exclaimed, "Mr. Edison, I can always tell when you are near me. How do you account for that?" Edison replied by suggesting she marry him, and they were married eight days later.) The marriage disappointed him. Edison had assumed that because she was working as a telegrapher, she shared his interests. She did not. She was, in fact, eager to stop working and remain home. Edison seldom joined her there, spending nights and weekends in his lab. Mary had three children, then died suddenly in 1884.

The following year he met 19-year-old Mina Miller, the daughter of a prominent industrialist noted as a founder of the Chatauqua Institution (which mixed Protestant nondenominational adult education with cultural and recreational activities). During their year-long courtship, Edison taught her Morse Code. Of a drive in the White Mountains he wrote, "We could use pet names without the least embarrassment, although there were three other people in the carriage." During the trip he proposed by tapping and she tapped back "yes." They were married when he was 40 and she 20. Eager to understand his work, Mina helped in the laboratory until her children were born.

The Edison Israel describes is a complicated figure, a man with an interest in original thinkers of his day, including the theosophist Helena Blavatsky and the atheist Robert Ingersoll. But Israel's account

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excludes figures like the inventor Nicola Tesla, who worked for Edison when he first came to America and blamed Edison for his frustrations in selling the superiority of alternating current. The apparent decision to limit this narrative to evidence from the voluminous papers in the Edison archive narrows Israel's biography, making it very much like a memoir written by a wise and sympathetic observer.

BOOKS: PHYSICS

The Long Life of a Thoughtful Teacher

Frank Wilczek

The content of this book is more accurately conveyed by its subtitle, *A Life in Physics*, than by *Geons, Black Holes, and Quantum Foam* because it is very much an account of John Wheeler's life. Physics is the central strand, but no topic is presented in depth and there are few substantial departures from a straight biographical narrative. In particular, the farther reaches of general relativity appear only in the last third of the book, and then only in very soft focus. The false advertising is unnecessary: Wheeler is such a remarkable scientist and has so many students, friends, and admirers that his autobiography will attract a wide audience.

Geons, Black Holes, and Quantum Foam
A Life in Physics
by John Archibald Wheeler with Kenneth Ford
Norton, New York, 1998. 380 pp. $27.95, C$39.99. ISBN 0-393-04642-7.

Wheeler's early research was mainly in nuclear physics. Notably, he collaborated closely with Niels Bohr on the liquid drop model of nuclear fission. Their work was of immense practical importance, since it guided efforts leading to the atomic bomb. Moreover, it was among the first where dynamics of "medium sized" (in the current jargon, mesoscopic) objects, at the border between quantum and classical behavior, were analyzed. This subject is undergoing something of a renaissance in the new context of microelectronics, and the beautiful mathematical methods Wheeler developed retain their vitality.

Wheeler strikes a rare wistful note in discussing the development of the "unified model" of nuclei. Roughly speaking, this approach constructs a flexible mathematical description that accommodates both the continuum, liquid drop, picture of a nucleus and the alternative, seemingly very different, picture based on a gas of protons and neutrons. The consistent scheme also supports the formulation of fruitful pictures combining gas and liquid aspects. Wheeler started to develop this idea, but got delayed awaiting Bohr's reactions and was distracted by the whirl of wartime and immediate postwar activity. In the end he was scooped by Rainwater, Aage Bohr, and Mottleson, who received Nobel Prizes for their work.

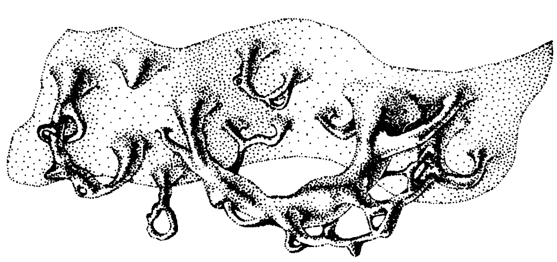
Unlike most of his colleagues, Wheeler continued to be heavily involved in government and military work after the war years. He brought real passion to his research on thermonuclear weapons, partly stemming from the death of his younger brother toward the end of World War II (one of many deaths that Wheeler thinks might have been avoided with a more vigorous scientific effort). The book contains much material on his experiences in this work, which will be of value to historians and policy-makers.

A second main strand in Wheeler's scientific career was quantum electrodynamics. In the early 1940s his world-line intersected that of Richard Feynman, who became his graduate student. The two obviously enjoyed one another immensely, and in their individual papers they frequently refer to each other. Their main collaboration concerned a novel formulation of electrodynamics, in which one eliminates the electromagnetic fields and formulates a self-contained theory of charged particles alone. The finite speed of propagation of influence, which ordinarily appears in the equations for how fast the fields respond to perturbations, is instead encoded in forces that depend on where other particles were in the past. But the most startling feature of their formulation is this: Due to the time-reversal symmetry of the basic equations, the forces also depend on where other particles will be in the future! Wheeler and Feynman showed that under most circumstances the conventional behavior would nevertheless emerge statistically. This work has so far not had much impact on the progress of physics, but it may yet. For although the working assumption of current physical theory is that, early on, our present complicated universe emerged from a much simpler state, there is one notoriously puzzling case where the future seems to be simpler than the past—apparently it is in late history of the universe, not at its origin, that the cosmological term vanishes.

Another startling Wheeler idea from this period is that positrons are electrons traveling backward in time. Then there could be in the universe just one ur-electron, which travels both forward and backward in time to look like many electrons and as many positrons. That would explain why all electrons are alike. In its naïve, cosmological application this idea is certainly wrong, but Feynman exploited Wheeler's backwards-in-time picture of positrons in his great work on quantum electrodynamics.

The third phase of Wheeler's research began in his late 40s, when he took up general relativity. Ironically, his initial goal was to show that something as absurd as the singularities that Oppenheimer and Snyder predicted would arise from stellar collapse could not exist. After lengthy struggles probing all loopholes, Wheeler became convinced that, in fact, their analysis could not be avoided. He named, and became an eloquent advocate for, "black holes." Through his own work, by training a remarkable group of students, and by his extravagantly eloquent writings, Wheeler helped bring what had been a backwater of physics into vibrant new life. This story, only sketched here, is spelled out in his wonderful, accessible books *Spacetime Physics* (with Taylor), *Gravitation* (with Misner and Thorne), and *A Journey into Gravitation and Spacetime*.

Many scientific autobiographies are spiced with sharply expressed views of historical events, gossip, and critical judgments on current scientific issues. In Wheeler's book there is relatively little of this (a mild exception was mentioned above). Instead we find extended tributes to his parents, many briefer ones to colleagues and students, a celebration of his long and harmonious marriage, and many happy photographs. We sense the essential sweetness of a life in which great gifts were fulfilled. Those who know "Johnny" will recognize him here, and others now have the chance to see how a remarkable man achieved seemingly eternal, joyful youth.



Quantum foam. At 10^{20} times smaller than the size of a proton, spacetime is stirred into a "writhing turbulence of myriad multiply connected domains," ordinary ideas of length are lost, and ordinary ideas of time evaporate.

CREDIT: KIP THORNE/*BLACK HOLES AND TIME WARPS: EINSTEIN'S OUTRAGEOUS LEGACY*

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