

The Tragic Tale of a Genius

Dark Hero of the Information Age: In Search of Norbert Wiener, the Father of Cybernetics
by Pia Conway and Jim Siegelman.
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Freeman Dyson

Norbert Wiener was famous at the beginning of his life and at the end. For thirty years in the middle during which he did his best work, he was comparatively unknown. He was famous at the beginning as a child prodigy. His father, Leo Wiener, the first Jew to be appointed a professor at Harvard, was a specialist in Slavic languages. Leo was also an extreme example of a pushy parent. He drove Norbert mercilessly, schooling him at home in Greek, Latin, mathematics, physics, and chemistry. Fifty years later Norbert described, in his autobiography, *Ex-prodigy: My Childhood and Youth*, how the prodigy was nurtured:

He would begin the discussion in an easy, conversational tone. This lasted exactly until I made the first mathematical mistake. Then the gentle and loving father was replaced by the avenger of the blood.... Father was raging, I was weeping, and my mother did her best to defend me, although hers was a losing battle.

At age eleven, Leo enrolled Norbert as a student at Tufts University, where he graduated with a degree in mathematics at age fourteen. Norbert then moved to Harvard as a graduate student and emerged with a Ph.D. in mathematical logic at age eighteen. While he was growing up and trying to escape from his notoriety as a prodigy at Tufts and Harvard, Leo was making matters worse by trumpeting Norbert's accomplishments in newspapers and popular magazines. Leo was emphatic in claiming that his son was not unusually gifted, that any advantage that Norbert had gained over other children was due to his better training. "When this was written down in inflexible printer's ink," said Norbert in his autobiography, *Ex-prodigy*, "it declared to the public that my failures were my own but my successes were my father's."

Miraculously, after ten years of Leo's training and seven years of tortured adolescence, Norbert settled down to adult life as an instructor at the Massachusetts Institute of Technology and became a productive mathematician. He climbed the academic ladder at MIT until he was a full professor, and stayed there for the rest of his life. For thirty years, roughly from age twenty to age fifty, he faded from public view. He remained famous in the MIT community for his personal eccentricities. He liked to think aloud and needed listeners to hear what he was thinking. He made a habit of wandering around the campus and talking at great length to any colleague or student that he encountered. Most of the time, the listeners had only a vague idea of what he was talking about. Colleagues and students who valued their time learned to hide when they saw him coming. At the same time, they respected him for his achievements and for his encyclopedic knowledge of many subjects.

¹Simon and Schuster, 1953.

Wiener was unusual among mathematicians in being equally at home in pure and applied mathematics. He made his reputation as a pure mathematician by inventing concepts such as the "Wiener measure" that have passed into the mainstream of mathematics. Wiener measure gave mathematicians for the first time a rigorous way to talk about the collective behavior of wiggly curves or flexible surfaces. While continuing to publish papers in the abstract realms of mathematical logic and analysis, he loved to talk with the engineers and neurophysiologists who were his neighbors at MIT and Harvard. He became

Norbert Wiener



deeply immersed in their cultures, and enjoyed translating problems from the languages of engineering and neurophysiology into the language of mathematics.

Unlike most pure mathematicians, he did not consider it beneath his dignity to apply his skills to the messy practical problems of the real world. He became a successful applied mathematician, helping to design machines and communication systems for use in war and peace. He understood, more clearly than anyone else, that the messiness of the real world was precisely the point at which his mathematics should be aimed. As an applied mathematician, he worked out a general theory of control systems and feedback mechanisms, a theory which he called "cybernetics." Cybernetics was a theory of messiness, a theory that allowed people to find an optimum way to deal with a world full of poorly known agents and unpredictable events. The word "cybernetics" comes from the Greek word for steersman, the man who steers a trail ship through stormy seas between treacherous rocks.

During World War II, Wiener worked with his engineer friend Julian

Bigelow, designing an optimum control system for antiaircraft guns. The design of the control system was an elementary exercise in cybernetics. Like his colleagues at MIT, Wiener was happy to be engaged in work that could help to win the war. To shoot down an airplane, it was necessary to predict the future position of the airplane at the time of arrival of the shell, knowing only the past track of the airplane up to the moment when the prediction was made. During the interval between prediction and arrival, the pilot of the airplane would be taking evasive action, changing his course in a way that could only be estimated statistically. To maximize the chance of destroying the airplane, the control system must take into account the

ther the Bell system nor the Wiener-Bigelow system was accurate enough to shoot down airplanes reliably. After proximity fuses became available in 1944, the Bell system was good enough.

When the war ended with the nuclear attacks on Hiroshima and Nagasaki in 1945, Wiener was outraged. In his eyes, the government had committed a crime against humanity, and the scientists who had created the bomb were to blame for allowing the government to exploit their skills for evil purposes. The nuclear attacks confirmed a belief that had been growing in his mind for many years, that the technology of communication and control which he had helped to create was fundamentally dangerous. He saw the nuclear attacks as a glaring example of the disasters that could result from science and technology when scientists were working in secrecy for military and industrial authorities. He feared that the nascent technology of computers and automatic machinery could lead to even greater disasters if it remained in the hands of secret military and industrial organizations. He decided from that moment on to have nothing to do either with government or with industry. He decided to devote a major part of his time to educating the public, to help the public to deal wisely with new technologies.

In January 1947, Wiener published in *The Atlantic Monthly* an article with the title "A Scientist Rebels," an eloquent statement of his refusal to cooperate with the government. "I do not expect to publish any future work," he wrote, "which may do damage in the hands of irresponsible militarists." His article immediately made him as famous at the age of fifty-two as he had been as a child prodigy. For the rest of his life, he continued to be well known as a political activist, writing articles and books that were widely read, traveling to many countries to meet with political leaders and concerned citizens. As he explained in his second autobiography, *I Am a Mathematician: The Later Life of a Prodigy*, "I thus decided that I would have to turn from a position of the greatest secrecy to a position of the greatest publicity, and bring to the attention of all the possibilities and dangers of the new developments."

For the last decade of his life, Wiener was a prophet who spoke and wrote eloquently about the displacement of human beings by automatic machinery. He saw this displacement as a likely consequence of his own inventions. But he spoke and wrote with equal eloquence of the good that automatic machinery could do, if it were used intelligently to make poor societies rich, to enable poor countries to jump from an agricultural economy to an industrial economy without enduring the horrors of nineteenth-century industrialization. He published two books that became best sellers, *Cybernetics; or, Control and Communication in the Animal and the Machine*, in 1948,² and *The Human Use of Human Beings: Cybernetics and Society*, in 1950.³ Before modern electronic computers existed, these books predicted

²Doubleday, 1956

³John Wiley.

⁴Houghton Mifflin.

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with some degree of accuracy the economic and political effects of computer technology on human societies. "We were here," he wrote.

in the presence of another social potentiality of unheard-of importance for good and for evil.... It gives the human race a new and most effective collection of mechanical slaves to perform its labor.... However, my labor that accepts the conditions of competition with slave labor accepts the conditions of slave labor, and is essentially slave labor.... The answer, of course, is to have a society based on human values other than buying or selling.

He concluded his sermon with a sentence borrowed from the medieval poet Bernard of Cluny, "The hour is very late, and the choice of good and evil knocks at our door."

Wiener shared the fate of other major prophets, being honored abroad more than at home. He was honored most spectacularly in India and Russia. He traveled several times to India and was welcomed personally by Nehru and other Indian leaders. He went on lecture tours, and gave advice about industrial policy to the Indian government. He advocated the founding of technical institutes and the encouragement of home-grown technical industries. His advice is bearing fruit fifty years later, as India emerges as a major center of information technology and American business is outsourced to Indian firms. He also traveled to Russia, where he received equally strong official adulation but felt less at home. He told the Russians that science must be free from the restraints of political ideology. He found the ideology of Marxism as destructive of human values as the ideology of free-market capitalism. The Soviet government ignored his plea for scientific freedom but enthusiastically supported cybernetics.

The cult of cybernetics in Russia was more philosophical than practical, but it may have had some lasting effects. Perhaps it contributed to the recent emergence of a computer-literate society and a home-grown software industry. In 1964, at the age of sixty-nine, Wiener was invited to give lectures about cybernetics in Sweden, where his ideas also had a wide following. The day after his arrival, he died suddenly of a pulmonary embolism on the steps of the Royal Institute of Technology in Stockholm.

2.

Dark Hero of the Information Age is the third biography of Norbert Wiener, unless there are others of which I am ignorant. First came a joint biography of Wiener and the mathematician John von Neumann, *John von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death*, by Steve Heims in 1980.¹ Then came *Norbert Wiener, 1894-1964*, by Pesi Masani in 1990.² And now the book under review. The main justification for a new biography is that the three biographies emphasize different aspects of Wiener's life and character.

The Heims biography emphasizes politics. It is mainly concerned with Wiener's activities as a social critic in the last third of his life. It presents the parallel lives of von Neumann and Wiener as a simple struggle between black and white, with von Neumann as the evil genius of science in the service of war, and Wiener as the good genius of science in the service of peace. In a review of the Heims book which I published in *Technology Review* in 1981,³ I wrote:

If Heims had been willing (to stay in the background), to present his work as a historical narrative with the protagonists speaking for themselves, he would have made an important contribution to the understanding of the great moral dilemma of our age. Unfortunately,.... he stands at the front of the stage between his characters and the audience, making it difficult for us to hear their voices and to see the drama of their lives [in historical perspective].

The authors of the new biography cite Heims frequently, but do not accept his judgments uncritically. They present the relationship between von Neumann and Wiener as it appears in the historical documents, a friendship based on common interests and deep mutual respect. The paths of von Neumann and Wiener diverged after World War II when von Neumann was willing to accept money from the United States government to support his research and Wiener was not. After that, they saw little of each other, but the mutual respect endured. When von Neumann started building a digital computer in Princeton in 1946, Wiener recommended his collaborator Julian Bigelow to be in charge of the hardware, and Bigelow became von Neumann's chief engineer with Wiener's blessing.

Pesi Masani's biography is from a scholarly point of view the best of the three. Masani was a professional mathematician, born in India and settled in the United States. He collaborated with Wiener and published several substantial papers with him in the 1930s. After Wiener died, Masani edited his collected papers for publication. Masani was intimately familiar with every detail of Wiener's work. The Masani biography is the only one that portrays him as a working mathematician. Any biography that skips the mathematics can give only a vague impression of Wiener's way of thinking. Masani states his purpose at the beginning of his book: "This book attempts to trace the interaction between mathematical genius and history that has led to the conception of a stochastic cosmos."

Masani explains Wiener's mathematical ideas with admirable clarity, and he has found and reproduced many historical documents that the other biographers have missed. One particularly illuminating document that Masani reproduces in full is a long and friendly letter from von Neumann to Wiener, written in November 1946, discussing the mysteries of the human brain and the various ways in which the mysteries might be explored. "I am most anxious to have your reaction to these suggestions," von Neumann writes. "I feel an intense need that

¹MIT Press.

²Birkhäuser.

³February/March issue, pp. 17-19.

discuss the subject extensively with each other." Von Neumann's letter shows how far he had come in foreshadowing the era of molecular biology that he never lived to see. The letter also shows how far Heims diverged from the truth when he portrayed von Neumann and Wiener as polar opposites. They shared a passionate interest in biology. Both of them saw a deeper understanding of biology as the ultimate goal of their explorations of the science of computing and information.

After Heims has described Wiener's politics and Masani has described his mathematics, what is there left for a third biography to do? This third biography gives us a new and intimate portrait of Wiener as a person, and describes his stormy relationships with his friends and family. Conway and Siegelman have done a thorough job of historical research, interviewing most of the surviving witnesses, and documenting the narrative with detailed references to published and unpublished papers, letters, and interviews. The title, *The Dark Hero of the Information Age*, indicates their main preoccupation. Their aim is to explore the roots of Wiener's lifelong malaise and often weird behavior. Their intimate portrait became possible because they enjoyed the cooperation of Wiener's daughters, Barbara and Peggy, who gave them free access to Wiener's private papers and family records. Peggy wrote in a letter, "Serious unanswered questions remain concerning Dad's life and relations with his colleagues. It is very important to tell the whole story," and Barbara agreed. The main obstacle to full disclosure disappeared with the death of Wiener's wife Margaret at the age of ninety-five in 1989. Margaret was a faithful and protective wife to Wiener as long as he lived, but was not so speaking terms with her daughters.

The drama of Wiener's personal life begins with his years as an infant prodigy, tormented by his brilliant but tyrannical father. Either as a result of his father's training or from genetic predisposition, he suffered from violent swings of mood that continued throughout his life. If he had been seen by a modern psychiatrist he would probably have been diagnosed as manic-depressive. He sank periodically into deep depressions that continued for several months, and then emerged into intervals of restless and creative activity. The depressions tended to come more often when he stayed at home, and that was one of the reasons why he spent so much of his time traveling. Away from home, the distractions of public lectures and ceaseless conversation with friends and admirers kept his spirits high.

Another major theme of this biography is Wiener's marriage. His wife, Margaret, was a student of his father, and the marriage was arranged by his parents. Margaret was chosen to take over from his parents the job of caring for him and organizing his life. This job she performed well, running a frugal household and providing a comfortable home for him and the children. She said to a friend in the early days of the mar-

riage, "Norbert does the math and I do the arithmetic." She coped with his moods and raised his daughters.

But Margaret was in some respects even crazier than Wiener. She had emigrated from Germany to America at the age of fourteen. She was a fervent admirer of Adolf Hitler and kept two copies of *Mein Kampf* displayed prominently in her bedroom, one in German and one in English. She made no secret of her political views, to the intense annoyance of Wiener, who was himself Jewish and had many friends who were victims of Nazi persecution. When the daughters were teenagers and began to acquire boyfriends, she made their lives miserable by accusing them of nonexistent sexual delinquencies. When they once went out with a girlfriend and came home with their ears pierced, Margaret was furious



Norbert Wiener and his wife, Margaret, in Switzerland, 1925

and accused them of trying to seduce their father. As a result of her paranoid accusations, both daughters escaped from home as soon as they could and thereafter had little contact with her or with Wiener.

The most tragic episode of Wiener's life happened in 1951 when he was fifty-seven years old and passionately involved in a collaboration with his friend Warren McCulloch and a group of young colleagues that he called "the boys." McCulloch was a neurophysiologist who had moved from Illinois to MIT to work with Wiener. They planned to explore the connections between Wiener's theory of feedback control and the functioning of living neurons and brains. "The boys" were a brilliant team, including Jerome Lettvin, who later became a leading experimental biologist. Margaret was insanely jealous of McCulloch and his boys, and resolved to break up their friendship with Wiener. At a dinner with some colleagues in Mexico, who reported the episode to Lettvin many years later, she informed Wiener that McCulloch's boys had seduced his daughter Barbara when she was a teenager staying at McCulloch's house.

This story had no basis in fact, but Wiener believed it. He made no attempt to verify the accusation, and immediately wrote an angry letter to the president of MIT dissolving all connection between himself and the McCulloch team. From that day until

the end of Wiener's life, the contact remained broken. McCulloch never knew why. The effect of the breach on McCulloch and his boys was devastating. The effect on Wiener was also profound. His foray into biology, and his hopes for unifying cybernetics with biology, were at an end. Margaret achieved her objective, to cut him off from his friends and have him for herself.

The personal drama of the breach between Wiener and McCulloch is the centerpiece of this biography, the event around which the rest of the narrative revolves. Perhaps the main reason for the book's existence is to give the Wiener daughters a chance to tell their story, to exorcise the family curse by exposing their secrets to the light of day. Wiener is the dark hero, and Margaret is the dark villain. The book

reads more like a novel than a conventional biography. And inevitably the reviewer wonders whether the story is true. Margaret is now the one who is accused and will never have a chance to answer her accusers. She never spoke with the authors, and left no friend behind to speak for her. The evidence against her is well documented and seems convincing. And still, the reviewer wonders. The evidence that Margaret claimed a seduction had taken place comes from a single informant, the late Arturo Rosenbluth, who told the story to Jerome Lettvin and others, ten years after the event. This is not the sort of evidence that would convict a murderer in a court of law. It is not likely, but possible, that Rosenbluth, who died in 1970, might have had ulterior motives for concocting the story.

This biography belongs to a genre that has recently become fashionable, emphasizing the airing of family secrets and the exposure of human weaknesses. There has been a spate of books exposing the human weaknesses of Einstein, Madame Curie, and other scientific heroes. Such books are worth reading if they give us a balanced mixture of human drama with scientific substance. Many of them make an attempt at balance, giving us stories and scandals undiluted with science. The authors of this book have succeeded in bringing Wiener to life as a great figure in the world of science as well as a tragic hero in a domestic drama. They show him as he was, a mixture of Galileo and Othello. Because they are ignorant of mathematics, they cannot give the reader a detailed picture of what Wiener actually did. But they answer the crucial questions: what cybernetics was, what Wiener intended to do with it, and why it seems to have disappeared from the scene after Wiener's death.

Wiener defined cybernetics to be "the entire field of control and communication theory, whether in the machine or in the animal." The languages of communication theory are mathematical. To understand the history of cybernetics, it is important to understand that mathematical communication has two languages, which we call analog and digital. Analog communication describes the world in terms of

continuously variable quantities such as electrical voltages and currents that can be directly measured. Digital communication describes the world in terms of zeros and ones, each zero or one representing a logical choice between two discrete alternatives. Analog communication is the language of analysis. Digital communication is the language of logic.

Wiener was fluent in both languages and intended cybernetics to include both. In 1940 he wrote a memorandum explaining in detail why digital language would be preferable for the computers whose existence he already foresaw. But his own contributions to communication theory happened to be written in analog language, for four reasons. First, his work as a pure mathematician had mostly been in analysis. Second, his practical experience with aircraft prediction was concerned with analog measurements and analog feedback mechanisms. Third, his conversations with neurophysiologists had convinced him that the language of sensory-motor feedback signals in the brains of humans and animals is analog. Fourth, the transmission of signals by chemical hormones is evidence that the action of the brain is at least partly analog. For all these reasons, Wiener's book *Cybernetics*, which summarized his thinking in 1948, was written in analog language. And for the last ten years of his life, as he traveled from country to country preaching the gospel of cybernetics, he used analog language almost exclusively. In spite of his original intentions, cybernetics became a theory of analog processes.

Meanwhile, also in 1948, Claude Shannon published his classic pair of papers with the title "A Mathematical Theory of Communication," in *The Bell System Technical Journal*. Shannon's theory was a theory of digital communication, using many of Wiener's ideas but applying them in a new direction. Shannon's theory was mathematically elegant, clear, and easy to apply to practical problems of communication. It was far more user-friendly than cybernetics. It became the basis of a new discipline called "information theory." During the next ten years, digital computers began to operate all over the world, and analog computers rapidly became obsolete. Electronic engineers learned information theory, the gospel according to Shannon, as part of their basic training, and cybernetics was forgotten.

Neither Wiener nor von Neumann nor Shannon, nor anyone else in the 1940s, foresaw the microprocessors that would make digital computers small and cheap and reliable and available to private citizens. Nobody foresaw the Internet or the ubiquitous cell phone. As a result of the proliferation of digital computers in private hands, Wiener's nightmare vision of a few giant computers determining the fate of human societies never came to pass. But other aspects of Wiener's vision of the future are coming true. We see, as he predicted, millions of skilled human workers displaced by machines and sinking into poverty. We see the basis of the wealth of nations moving from the manufacture of goods to the processing of information. We see the beginnings of an understanding of the mysteries of the human brain. We still have much to learn from Wiener's vision. □