

Chester F. Carlson: A Man to Remember

By Dennis G. and Rita M. Hall

Chester Carlson Chronology

- 1906 Chester F. Carlson born in Seattle, WA
- 1928 Graduates from Riverside Junior College
- 1930 Graduates from Caltech, B.S. in Physics
- 1937 Submits first patent; issues on Nov. 25, 1940
- 1938 Demonstrates Electrophotography
- 1939 Graduates from New York Law School
- 1942 Basic Xerography Patent (2,297,691) issues
- 1944 Basic Machine Patent (2,357,809) issues
- 1944 Signs development agreement with Battelle
- 1947 Haloid becomes a licensee
- 1948 Electrophotography becomes Xerography
- 1948 Public demonstrations at OSA Annual Meeting and Waldorf Astoria Hotel in Manhattan
- 1956 Haloid becomes Haloid Xerox
- 1959 Xerox 914 copier unveiled
- 1964 Named Inventor of the Year
- 1968 Chester Carlson dies in New York City



Chester Carlson's invention of electrophotography, the process that gave birth to the modern-day photocopy industry, demonstrates how enormous can be the impact of a gifted individual working alone. Ultimately, it took teamwork to turn his invention into a series of successful products, but the path-breaking idea that put those teams to work came from one man, Chester Carlson. The personal and professional challenges he overcame along the way make the impact of his contribution even more remarkable.

Chester Carlson (age 10), his mother Ellen and father Olaf in Crestline, CA (1916).



Chester Floyd Carlson was born in Seattle, Washington, on February 8, 1906. Theodore Roosevelt was in the White House, and Sir J. J. Thomson would win that year's Nobel Prize in Physics for his 1897 discovery of the electron. By the time Chester was six years old, his father Olaf, a barber who suffered from both tuberculosis and arthritis, had moved his family of three from Seattle to Arizona to Mexico to California, searching for a healthful climate and a reasonable living. As his father's worsening health brought the family to the brink of poverty, it became increasingly necessary for Chester to work. By the time he entered high school, Chester's after-school and weekend jobs were providing most of the family income. Later in life, he suggested that his attraction to the problem of copying documents was rooted in two of those part-time jobs, one as a janitor in a newspaper office and another setting type for a small printing business. Both left him interested in "the difficult problem of getting words onto paper or into print."³



Chester Carlson (age 22) in Death Valley on a 1928 field trip with H. H. Bliss.

Tragedy struck when Chester's mother, Ellen, contracted tuberculosis and died in 1923, leaving only her 17-year-old son to support and care for his invalid father. Despite heavy responsibilities at home, Chester Carlson graduated from high school in San Bernardino, California in 1924 and began to consider how he might attend college.

Before graduating, Chet (as he was called) had become interested in the California Institute of Technology when a group of Caltech students visited his high school. Despite being a good science student, in 1924 he was in

Chester Carlson, at Georgetown University in 1964, on the occasion of being named Inventor of the Year by the Patent, Trade-mark & Copyright Research Institute.

no financial position to consider applying to Caltech. Instead, he postponed college for a year while he worked, saved a little money, and took a few post-graduation high school courses. In 1925, he enrolled in a cooperative program at Riverside Junior College (RJC) in Riverside, California. The program, designed around six-week class periods alternating with six-week work blocks, gave financially needy students the opportunity to complete two years of college in four years. No stranger to working hard, Chester completed the RJC program in 1928 after only three years by taking heavier-than-normal course loads, even while working extra hours in a cement plant to support his father. His diary entries for that period show that Chester Carlson was inspired by RJC physics teacher H. H. Bliss, whose influence no doubt helped keep Chet's spirit and motivation high in the face of a strenuous workload. The following is a portion of the testimonial Chet wrote in his diary on January 2, 1928:

"I must here write an appreciation of Mr. H. H. Bliss. I think he has contributed more to my education than anyone else (except probably my mother and father). For three years, I was a 'Coop' at Riverside Junior College where he was (and is) head of the Cooperative work, Physics and Electricity teacher. He is the best 'teacher' I have ever known."⁵

After spending the summer working long hours in a cement plant and taking intensive mathematics courses to prepare himself for the next phase of his education, the 22-year-old Chester Carlson entered Caltech as a junior in Fall, 1928. This was the Caltech of Robert Millikan, William Smythe, Fritz Zwicky, Linus Pauling and Thomas Hunt Morgan, to name a few. Chester found the coursework there so demanding that for the first time in many years, part-time jobs simply were out of the question when classes were in session. Whereas most of his fellow students received at least some financial support from their parents, it was just the opposite for Chester. He struggled to study, care for his father, and earn what he could to pay the costs of his education. When he graduated from Caltech in 1930 with a B.S. degree in physics, Chester Carlson was in debt and, according to his memoirs, it would be 1934 before his assets were "up to zero."³



The diary he kept during his days at Caltech shows that Chester was understandably concerned about his future. On its pages, he analyzed what he perceived to be his own strengths and weaknesses and compared that profile against ways he might make a living. He summed up his analysis this way:

"I would probably be most successful in endeavors where marked proficiency in mathematics, scientific knowledge, original thinking, novel ideas, thorough work was valuable and where speed, great skill at manipulation of apparatus, careful experimental work, ability to work with others, great physical endurance or power were not of utmost importance."⁵

He had already been attracted years earlier by the idea of becoming an inventor, and the idea was still with him at Caltech: "I have my eye on this field and it may be my best chance," he wrote.⁵ Almost 30 years later, in 1959, Chester described what motivated him to become an inventor this way:

"I had read of Edison and other successful inventors and the idea of making an invention appealed to me as

one of the few available means to accomplish a change in one's economic status, while at the same time bringing to focus my interest in technical things and making it possible to make a contribution to society as well."³

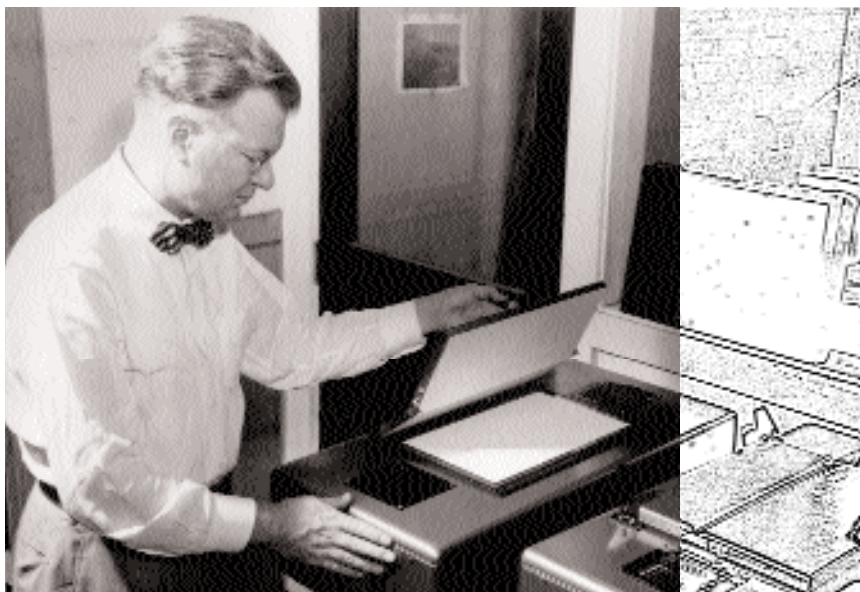
1930 was not the best year to be leaving school to enter the workforce. The 1929 stock-market crash had ushered in the Great Depression—by 1932, one out of every four US workers was without a job. The more than 80 job inquiries Chester Carlson mailed during the Spring semester of his senior year produced only one interview and no offers. When the Bell Telephone Company conducted campus interviews at the very end of his senior year, Chet received and accepted his only job offer: laboratory work in New York City. The job quickly proved too routine for Chet's tastes, so when the opportunity arose, he transferred to the patent department to assist one of the attorneys, thus launching his career in patent law.

Chet was laid off in 1933 as the Depression deepened. But he quickly found a similar position, first at a New York law firm, and then, a year later, at P. R. Mallory and Company, where he remained for a dozen years (1934-1946). While there, he entered and graduated from New York Law School (1936-1939) and eventually rose to become head of the Patent Department at Mallory.

A full-time job and law school would have been enough to absorb most people's time and energies, but it was during this very period when Chester also began to focus on how difficult it was to make enough copies of the drawings and documents needed to process and file patents. What was needed, he thought, was a simple push-button copy machine to make the process more manageable. In 1935, Chester Carlson began doing research in the New York Public Library on ways to use light to transfer an image. Within two years, he had come upon and studied the phenomenon of photoconductivity (discovered in 1873), devised a way to use it to transfer images, and filed the first of many patents (U.S. Patent 2,221,776, awarded Nov. 25, 1940).

Chester's ideas were well formed in 1938, but his mounting workload at Mallory and his law-school studies left him increasingly pressed for time. So in the Fall of 1938, he moved his apparatus from his kitchen into a simple one-room laboratory in Astoria, on Long Island, New York, and hired Otto Kornei, an out-of-work Austrian physicist and German refugee, to assist him. On the morning of Saturday, October 22, 1938, they made history by using static electricity and a photoconductive, sulfur-coated zinc plate to transfer "10-22-38 ASTORIA" from a glass plate onto paper, the world's first demonstration of electrophotography.

The basic idea appears simple by modern standards: use an image to shadow a charged photoconductor to create a charge pattern of the image, then stain that pattern with powder and transfer it to paper. But as Burland and Schein note in their 1986 article in *Physics Today*, "It is a tribute to the genius of Chester F. Carlson, the inventor of electrophotography, that he was able in 1938 to combine such little-understood physical phenomena into a process



Chester Carlson with an early photocopy machine.

that is now at the heart of a rapidly growing, \$20 billion industry."⁶

The road to a practical embodiment of Chester Carlson's discovery proved frustrating. From 1939 to 1944, Chet tried to interest at least 20 major companies in developing and commercializing electrophotography. Some were openly skeptical, some showed only mild interest, and others could imagine no market large enough to justify the development costs. In 1944, his patent work at Mallory brought him into contact with Russell Dayton from the Battelle Memorial Institute at just the time when Battelle's interest in the graphic arts was growing. Battelle found the idea sufficiently promising to sign a development agreement with Chester Carlson on October 6. That same year, an article on Chester's patents by freelance writer Nicholas Langer came to the attention of John Dessauer, director of research at Haloid Company, based in Rochester, New York. After several improvements by Battelle, Haloid President Joseph C. Wilson signed a license agreement with Battelle in January, 1947, more than eight years after Chester's original demonstration.

OPN readers will find it interesting that Battelle and Haloid chose the 1948 OSA Annual Meeting in Detroit as the venue for their first public demonstration of electrophotography, which they renamed xerography, a term constructed out of the Greek words for "dry" and "writing." The Detroit meeting drew 550 registrants and a

record-breaking 76 presentations, among them paper #48: "Xerography. A New Principle of Graphic Reproduction," by R. M. Schaffert (of Battelle), J. C. Wilson and colleagues.⁷

The demonstration took place at a special Friday afternoon general session of invited papers, chaired by OSA President Rudolf Kingslake. According to the Proceedings, "One high point of this general session was a beautifully executed demonstration of a new method of graphic reproduction, 'xerography,' developed jointly by Battelle Memorial Institute and the Haloid Company."⁸ There is no mention of the inventor in the Proceedings, but Chester Carlson fared much better when *Time Magazine* covered a second public demonstration, held at the Waldorf Astoria Hotel in Manhattan. The November 1, 1948, *Time* carries a picture of "Xerographer Carlson" and quotes a publisher present at the demonstration as saying: "This looks like the beginning of a revolution."⁹

That publisher was right, but history shows the revolution was still very much in its infancy in 1948. Beginning in 1950, early Haloid products would use xerography to produce offset masters. The first Xerox 914 office copier would not roll off the production line until 1959, twenty-one years after Chester's historic 1938 experiment. According to Dinsdale:¹⁰ "In 1946 the Haloid Company sold \$6,750,000 worth of photographic and photocopy paper and machines for a net profit of \$101,000. By 1961... Carlson's inventions had transformed the Haloid Company into the Xerox Corporation with total sales of \$59,533,000 and profits of \$5,323,000."

Chester Carlson moved permanently to Rochester, New York in 1948 to be closer to development activities at Haloid and to pursue his other interests. But after 1948, the story of electrophotography becomes less and less the story of its inventor and more and more the story of Xerox Corporation. A gentle, amiable man, Carlson was content to remain in the background, serving as a consultant to Haloid and then Xerox while the popular products

his patents gave birth to gradually made him wealthy. Today, it would not be easy to make it through a day without the convenience of a photocopy machine. But hardly anyone today without some connection to the photocopy industry even recognizes the name Chester Carlson, or understands how long and difficult was the road he traveled to bring that convenience into being. Chester Carlson died in 1968 at the age of 62, survived by his wife Dorris H. Carlson and their daughter Catherine.

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Rita M. Hall is librarian at the Laureton-Pardee Intermediate School in Rochester, NY. When this article was written, Dennis G. Hall was director of The Institute of Optics at the University of Rochester. On July 1, 2000, he became associate provost for research and professor of physics at Vanderbilt University in Nashville, TN. While in transition, he retains a fractional appointment on the Rochester faculty through June 30, 2001.

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