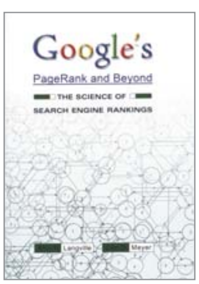
So, what is good about *Science on Stage*? It represents a well-written and super-detailed account of a handful of "science" plays from *Doctor Faustus* and *The Alchemist*, written centuries ago, to *Galileo*, *The Physicists*, and other plays of the first half of the 20th century. The book also contains excellent analyses of some contemporary science plays such as *Copenhagen* and *Arcadia* to provide, as the author writes, "a sense, through specific examples, of what I judge to be core science plays." Her comment is fair enough, provided that her subjectivity and bias are recognized. But I worry when Shepherd-Barr concludes that her book should "help teachers design and implement courses on science plays." Her definition of science plays is idiosyncratic, and teachers ought to cover all views of how science on stage can be presented, not just Shepherd-Barr's.

Google's PageRank and Beyond

The Science of Search Engine Rankings

Amy N. Langville and Carl D. Meyer
Princeton U. Press, Princeton, NJ, 2006. $35.00 (224 pp.). ISBN 0-691-12202-4

Suppose you have some time to kill and decide to spend it surfing the Web. You point your cursor at whatever page comes up in your browser, and pick a link to click at random. You click again at the page you've reached, and again, several more times. What is the probability that you will end up looking at the Web page of PHYSICS TODAY? Obviously, the chances can't be too high, because about 10 billion pages exist on the open Web, and you've just been searching at random. One would think that the chances would be about one in 10 billion. It's obvious, right?



No, not really. Think about it. To get to http://www.physicstoday.org you must be on a page that points to it. If that page points to a small number of pages, you will be more likely to get to PHYSICS TODAY. Furthermore, your chances of having gotten to that page are higher if more pages point to it. So the distribution is not really random at all. Your chances of landing on a particular page are influenced by the graph of the network—that is, the graph created by the hypertext links on the Web. In fact, currently the graph of the network puts PHYSICS TODAY somewhere around the 90th percentile of likelihood, meaning your chances of landing on the link are closer to one in a billion—still not very high, but an order of magnitude better than random.

How the Web graph affects the likelihood that a user will find a particular page and the mathematics of computing the probabilities for webpages combine to form the basis of one of the most successful algorithms in the history of computing: PageRank. The algorithm is at the heart of the Google search engine. When you type a search query to Google, it retrieves the list of pages that contain your search words—a computing feat in itself—but more important, it sorts those pages according to their "page rank," the outcome of the algorithm applied to the many billions of Web pages. So understanding the algorithm is the key to understanding how search engines work and to the many other derivative industries based on them. In fact, developing the first practical commercial version of the algorithm made Google's founders Sergey Brin and Larry Page, who developed PageRank at Stanford University, two of the richest men in America.

In *Google's PageRank and Beyond: The Science of Search Engine Rankings*, Amy Langville and Carl Meyer use the PageRank algorithm as the unifying theme to discuss the mathematics underlying search engines. Langville is an assistant professor of mathematics at the College of Charleston in South Carolina, and Meyer is a professor of mathematics at North Carolina State University in Raleigh. As easy as it is to explain the behavior of randomly surfing the Web, the actual mathematics of the Web graph involves Markov chains and the eigenvectors of extremely large graphs. Langville and Meyer present the mathematics in all its detail, which would make for a dry book if that was all they presented. But they vary the math with discussions of the many issues involved in building search engines, the "wars" between search engine developers and those trying to artificially inflate the position of their pages, and the future of search-engine development. The authors also include a number of asides and boxes that discuss amusing anecdotes and interesting issues that arise in the search-engine world.

Last year, I taught a course on Web architecture and programming in which one of the primary topics was PageRank and search-engine algorithms. While looking for a text to use for the course, I found several books on trying to improve the page rank of websites, and *Google for Dummies* (Wiley, 2003) by Brad Hill. But I found nothing that was appropriate for a graduate or advanced undergraduate course. Langville and Meyer's book neatly fits that bill.

Although not a textbook, *Google's PageRank and Beyond* makes good reading for anyone, student or professional, who wants to understand the details of search engines. For those interested in trying to implement search engines, the book can be invaluable. The authors, however, could have covered some additional search-related topics. For example, Langville and Meyer do provide Matlab code for many of their algorithms, but they could also have introduced Lucene, the open-source search engine. Their chapter on the future of search engines already seems a bit dated because they leave out such topics as Web 2.0, the Semantic Web, social networks, and multimedia search engines, all now starting to loom large on the ever-expanding search-engine horizon. But it seems unfair to criticize the authors for omissions in such a rapidly changing field as the science of the search engine, in which any book is doomed to need updating before it hits the market.

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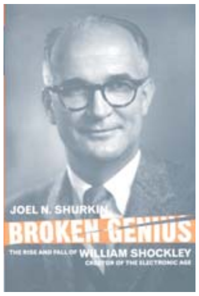
Broken Genius

The Rise and Fall of William Shockley, Creator of the Electronic Age

Joel N. Shurkin
Macmillan, New York, 2006. $27.95 (297 pp.). ISBN 1-4039-8815-3

Few physicists have been as controversial as William Shockley (1910–89), and few have been as influential in defining the contours of the electronics industry. Shockley headed the team that made the first point-contact transistor at the Bell Telephone Laboratories in New Jersey. Shockley later invented the bipolar transistor and seeded the semiconductor industry in California's Silicon Valley. But he was also known for his racist theories of intelligence. Because of his views, he became a reviled public figure and a pariah in the US scientific establishment.

In *Broken Genius: The Rise and Fall of William Shockley, Creator of the Electronic*



Age, Joel Shurkin offers the first biography of this important and troubled physicist. His book is a page-turner, which is rare for a scientific biography, but editing problems at times distract from the book's engaging story. Relying on a collection of Shockley's extensive private papers at Stanford University, Shurkin paints a nuanced portrait of the physicist, highlighting his scientific achievements and personal shortcomings. To explain the trajectory of Shockley's life, Shurkin reveals much of his subject's childhood and family background. According to Shurkin, Shockley was raised in a family that had a strong paranoid streak, which might explain Shockley's own mental disorders. His father, a mining engineer, encouraged his son's scientific interests. Shockley's childhood was also a lonely one, which left him with a severe lack of social skills.

Shockley was educated in physics at MIT and Caltech and later joined the technical staff of Bell Labs. During World War II, he made his first significant contributions to the area of operations research. Applying statistical techniques to the conduct of warfare, he greatly increased the efficiency of flight crews hunting German submarines in the Atlantic Ocean. His research also played a pivotal role in the firebombing of Japanese cities. According to Shurkin, Shockley's work in operations research might have been his greatest professional achievement. But the war was also a time of personal strain, which led Shockley to a suicide attempt and increasing alienation from his wife, Jean.

After the war, at the request of management at Bell Labs, Shockley organized a new research group to develop a solid-state switch. Among his top recruits were John Bardeen and Walter Brattain. Shurkin claims that Bardeen and Brattain's discovery of the point-contact transistor was the turning point in Shockley's life. Shockley, who had not been involved in Bardeen and Brattain's day-to-day work, was afraid that he would not get any credit for the invention of the transistor. As a result, he isolated himself in an effort to reassert his intellectual primacy. Competing with his own group, Shockley invented the bipolar transistor, and he also produced a seminal textbook, *Electrons and Holes in Semiconductors: With Applications to Transistor Electronics* (Van Nostrand, 1950). Although his research landed him the Nobel Prize in Physics, his tactics also alienated his collaborators and convinced Shockley's superiors that he was not of management caliber. As a result, it became increasingly clear to Shockley that his future at Bell Labs was limited.

In the early 1950s, Shockley experienced a mid-life crisis, along with amplified mental and behavioral problems. He divorced his wife, who was then fighting cancer, and married a psychiatric nurse, Emmy Lanning. He also decided to go into business for himself and established the Shockley Semiconductor Laboratory in California. The business was a dismal failure, partly because of Shockley's propensity to compete with and offend his own staff. But the startup was also the origin of the semiconductor industry in Silicon Valley, as the remarkable group of scientists Shockley had recruited went on to establish major firms such as Fairchild Semiconductor and Intel Corp. By the mid 1960s, Shockley, humbled by his business failure and by the successes of his staff, joined the electrical-engineering faculty at Stanford.

The most interesting part of Shockley's biography is Shurkin's discussion of his racist theories of heredity. Using his Nobel Prize fame and showing great skill in manipulating the press, Shockley became the most vocal and visible proponent of eugenics in the US. From the late 1960s through the 1970s he advocated the ideas that intelligence was hereditary and that blacks as a group were less intelligent than whites. He also claimed that the less intelligent should be prevented from having children. His views, expressed during the civil rights movement, led to considerable public outrage, and he was also attacked and vilified by the scientific establishment. His reputation destroyed, Shockley became increasingly isolated and reclusive until his death in 1989.

Broken Genius has a lot going for it. It offers interesting insights into Shockley's remarkable rise and fiery demise. Yet the book's production should have been handled with greater care. The biography is riddled with factual mistakes and misspelled names. The narrative is also disjointed at times and would have benefited from more careful editing. In short, Shurkin's book is an interesting and enjoyable read, but one could have hoped for a better-crafted biography.

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