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BOOKS & ARTS

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Shock result? William Shockley (centre) shared the 1956 physics Nobel with John Bardeen (left) and Walter Brattain for their work on transistors.

The Moses of Silicon Valley

William Shockley's work led to the foundation of the US computer industry.

Broken Genius: The Rise and Fall of William Shockley, Creator of the Electronic Age
by Joel N. Shurkin
Macmillan Science: 2006. 400 pp. £19.99, $27.95

Paul Grant

William Shockley was arguably the most enigmatic, provocative and controversial twentieth-century US physicist. His notoriety derived both from his perceived indirect role in the invention of the transistor, alongside his fellow 1956 Nobel laureates John Bardeen and Walter Brattain, and from his immersion in later life in the quagmire of the 'race intelligence' controversy. During his productive years as a physicist, Shockley excelled in collecting and exploiting ideas, both his own and those of his colleagues, but he failed dismally in exercising the leadership skills required to bring them to practical fruition. He has been called by some the 'Moses of Silicon Valley' — a fitting description in that he lured to the 'promised land' those who built the technical foundation for today's Information Age. But, like Moses, Shockley did not himself enter the land of milk and honey.

In the aptly titled biography *Broken Genius*, Joel Shurkin reveals Shockley to be a fascinating example of an aristotelian tragic hero whose flaw is readily discernible in the first act. In Shockley's case, this flaw was his overriding confidence in his own intelligence.

Shockley was an only child, born in 1910 in London to a gun-slinging mother and an MIT-educated father, a mining engineer whose search for gainful employment caused the family incessant relocation. As a child Shockley exhibited very disruptive behaviour at home, but was much better controlled in public (a glimpse of what was to come?). After his father's death in the 1920s, the family returned to the United States and settled in southern California. After high school, Shockley went to the California Institute of Technology and later MIT in the late 1920s and early 1930s during the 'golden age' of physics. He was heavily influenced by the epistemological debates of the time over determinism versus probability, which may well have fuelled his later attraction to statistical techniques.

After obtaining his PhD from MIT in 1936, Shockley was recruited by Mervin Kelly, director of Bell Telephone Laboratories. Then, as now, it was unusual for a newly minted PhD to go to an industrial laboratory. It was perhaps an indication that Shockley wanted his life to have some practical impact. Besides, it was the middle of the Great Depression, and Shockley now had a wife and family to support.

Kelly saw that the electromechanical relays that pervaded central telephone switchgear at the time would not be able to handle the ever-increasing traffic load. He asked his Bell Labs team to find an alternative. Although the 1930s was the heyday of the vacuum-tube amplifier, Shockley thought it might be possible to leapfrog that technology and find some 'solid state' effect that could act as a switching device.

Shurkin's tale of the events, technical and behavioural, that led to the successful fabrication of the point contact and junction transistor by the late 1940s is riveting, even if you know the story already. Much has been said about who did what and how credit should have been properly apportioned. I once asked Bardeen this question, and he gave his usual reply: "The answer is in the preface to Shockley's book." There, in the opening pages of his 1950 textbook *Electrons and Holes in Semiconductors*, Shockley attributes the invention of the transistor to Bardeen and Brattain, and to them alone. Bardeen had the key idea of minority carrier injection that made amplification possible, and Brattain had the skills to put the contacts close together. Yet without Shockley's participation and leadership, it is equally clear that the invention would not have occurred as soon as it did, and his later independent invention of the junction transistor was to emerge as the most practical embodiment of the device for the next decade.

Almost immediately after the discovery of the point-contact transistor, Shockley dissociated himself from many of his colleagues at Bell Labs, and eventually became disenchanted with the institution itself. Shurkin hints that this was the result of jealousy at not being fully involved in the final, crucial point-contact transistor experiments, and frustration at not progressing rapidly up the laboratory management chain. He had, in the words of his employees, an "unusual" management style.

For much of the early 1950s, Shockley was on leave from Bell Labs. His time was divided between teaching at Caltech and continuing to explore the statistical methods he introduced as a consultant to the military to help optimize naval and air-force tactical procedures in the Second World War. He adapted operations research techniques with the objective of maximizing damage to the enemy with the least expenditure in blood and money on his own side, a cost–benefit approach to conducting warfare.

Shockley's important wartime contributions have remained largely unknown, and Shurkin provides a rare focus on them. Unlike his better-publicized peers on the Manhattan Project and at MIT's Radiation Laboratory, Shockley was virtually on the battlefield and his recommendations had almost immediate effect. He was undoubtedly responsible for preventing many Allied casualties. He seemed to thrive in a leadership role within the command-and-control military culture. In some bizarre sense, he may have been cast in the mould of George Patton, Viscount Montgomery and Ulysses S. Grant — superb leaders of men in war, yet mostly dismal failures in times of peace.

After several years searching for an alternative career, Shockley finally left Bell Labs in 1956, returning to California to start the Shockley Semiconductor Laboratory, with financial backing from the industrialist Arnold Beckman. Once more, Shockley displayed an extraordinary gift for recruiting talent, along with total incompetence in managing them. Unlike Kelly, who gave his stable of thoroughbreds their head, Shockley attempted to micromanage, forcing his agenda on his new hires, whose ideas were in fact much better than his own. In 1957, Shockley's staff revolted, with eight — the 'traitorous eight' — resigning en masse. They were reunited by the inventor and financier Sherman Fairchild, and Fairchild Semiconductor was born. By 1961, Shockley Semiconductor had folded. Seven years later, two of the eight, Robert Noyce and Gordon Moore, with financial help from the other six, founded Intel.

Shockley's consolation prize was a professorship at Stanford, which gave him time to pursue his fascination with the possible connection between heredity and intelligence. This soon morphed into his much-sensationalized claim that African-Americans are statistically inferior in intelligence to those of European descent.

Had Shockley not been a Nobel laureate, his assertions would probably have been ignored. But a Nobel prize confers a 'bully pulpit', along with the perception, by people in general and the press in particular, of being an expert in everything. However, as the physicist and pundit Bob Park has observed, "A Nobel prize in physics is not an inoculation against silly behaviour," and there are plenty of examples to back that up.

With the discovery of DNA, physics met genetics, and the full impact of their engagement is just beginning to be glimpsed. If someday a gene sequence is found that determines intelligence, just as there are sequences for Tay-Sachs disease or thalassaemia, what shall we do about it? Will we have a future, as depicted in the film *Gattaca*, in which parents can selectively tailor the genetic structure of their children? If most choose intelligence as the dominant gene for their offspring, we might end up with a world full of Shockleys. Hopefully, this brave new world will have its share of those with the grace under pressure of Tiger Woods, the spine-tingling voice of Luciano Pavarotti, and the flashing fingers of rock guitarist Angus Young.

Variety is indeed the spice of life. ■

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CRC Press: 2006. 526 pp. £92, $159.95

Francesca Happé

Are we witnessing an autism epidemic? The current prevalence estimates for autism, and for the wider range of autism spectrum disorders (ASDs), are around ten times greater than estimates from studies in the 1980s and 90s. About 0.6% of the population is thought to have an ASD, diagnosed on the basis of qualitative impairments in social interaction and communication, with restricted and repetitive interests and activities.

The claim that cases of ASD are on the increase is the first step in Richard Lathe's argument in *Autism, Brain, and Environment*. Based on the apparent increase, Lathe argues for an environmental explanation for what he terms "new phase autism". He recognizes the overwhelming evidence that autism is among the most heritable of psychiatric disorders, but argues for a two-hit mechanism, with genetic susceptibility and environmental factors combining to produce an ASD. His book is a clearly and accessibly written account of his proposal that environmental poisons, including heavy metals, interact with genetic vulnerability to cause damage to the limbic brain system and to physiological systems, including the gut and the immune system, resulting in autism.

This is a story that many readers will find plausible, and which Lathe supports with some good synthesis of established autism research. It is perhaps not surprising that he also cites less solid, unpublished research to support the hypothesis, nor that the limitations of such research, such as the lack of appropriate control groups, are little discussed. But this is, overall, a scholarly book providing a possible explanation of autism. It will be of interest to parents as well as professionals.

Lathe's story stands in marked contrast to *Understanding Autism*, a volume edited by