

[physicsworldarchive.iop.org](http://physicsworldarchive.iop.org)

# **Tragedy and the transistor**

**Ivan K Schuller**

From  
**Physics World**  
July 2006

© IOP Publishing Ltd 2008

ISSN: 0953-8585

**IOP**

**Institute of Physics Publishing  
Bristol and Philadelphia**

**Downloaded on Mon Oct 20 22:59:45 BST 2008 [132.239.69.137]**

number, then a lot of mass is lost too. “But it isn’t, is it? It comes down to the  $c$ , doesn’t it,” she concludes correctly.

Then Matilda asks the \$64 000 question: “Why did he [Einstein] choose the speed of light?” “Who knows? I don’t know. Albert possibly knows. But it’s also possible that he doesn’t, precisely. I’m guessing it was a guess,” replies Feynman, in Feynmanese, reminding us of the cartoon in which Einstein writes “ $E = ma^2$ ” on a blackboard, crosses it out and writes under it “ $E = mb^2$ ”. The real Feynman

would have said to luscious Matilda that “ $c$  is in  $E = mc^2$  because of Einstein’s method for synchronizing clocks using light signals. And here’s how that goes, babe...”

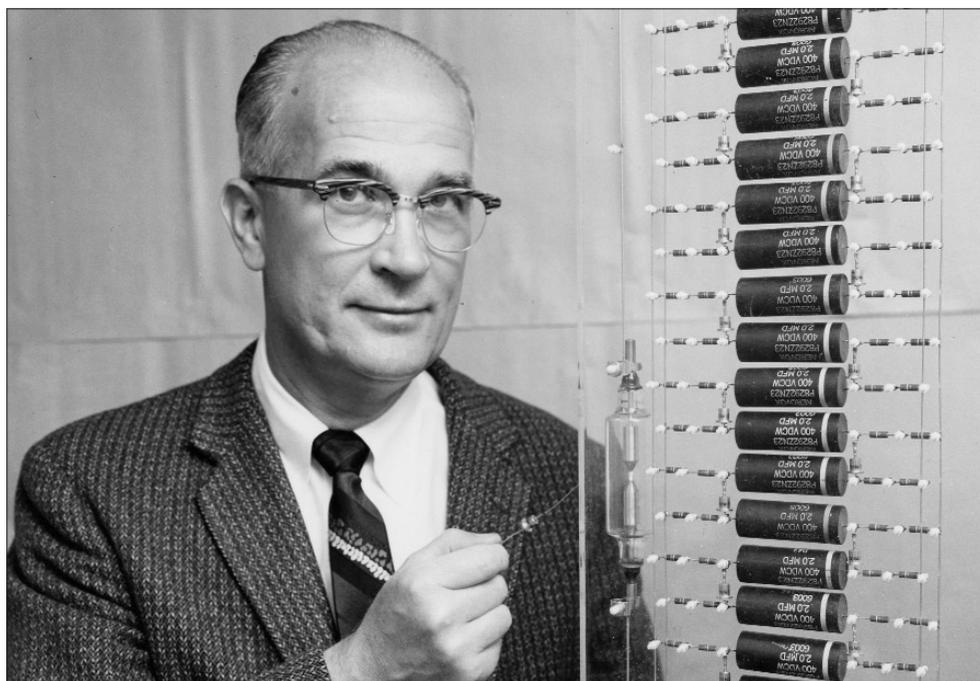
My New York Bronx ear detected Feynman speaking Brooklynese, not Long Islandese. But this is just hair-splitting for a UK audience. Could you imagine an American actor doing Wayne Rooney? Feynman is presented undeservedly as a geeky scientist, and the actor playing him is a bit long in the tooth for someone who was at

that time a very young-looking 27 year old. All in all, this is a play for which that hackneyed caveat emptor holds: any coincidence with characters living or dead is purely coincidental.

**Arthur I Miller** is Emeritus Professor of History and Philosophy of Science at University College London, e-mail [urchaim@ucl.ac.uk](mailto:urchaim@ucl.ac.uk). His latest book *Empire of the Stars: Friendship, Obsession and Betrayal in the Quest for Black Holes* (reviewed in *Physics World* October 2005) was shortlisted for the Aventis Prize

Ivan K Schuller

# Tragedy and the transistor



Fred English Photographs/AIP Emilio Segre Visual Archives

## Controversial thinker

The transistor changed the world, but Shockley later became infamous for his views on race.

## Broken Genius: The Rise and Fall of William Shockley, Creator of the Electronic Age

Joel N Shurkin

2006 Palgrave  
Macmillan 312pp  
£19.99/\$27.95hb

William Bradford Shockley was a scientist to the extreme. He was also a genius. His invention of the transistor changed the world, opening up new areas of science and technology, and he is even credited with the establishment of Silicon Valley. He successfully attacked problem after problem with the conviction that any question – whether from science or society – could be answered using the scientific method. But he ended his life friendless and discredited for his opinions on race and eugenics. Joel Shurkin, a Pulitzer Prize-winning science writer, is the first to trace this controversial life.

Shockley was born in London in 1910, but was raised in California and obtained his PhD from the Massachusetts Institute of Technology in

1936. During the Second World War he helped to develop what is now known as “operations research” – the application of statistical methods to solving complex problems, such as those in warfare. His research helped redesign air strikes against the Nazi forces with conclusive results in favour of the Allies. One of his simpler solutions – reducing the detonation depth of anti-submarine charges from 75 feet to 35 feet – increased the hit rate by a factor of five. He was even the first, together with James Fisk, to develop the concept of controlled nuclear fission. But this work was so highly classified that even the scientists from the Manhattan Project did not know about it and had to “re-invent the wheel”.

Shockley’s most important contri-

bution, however, was the invention of the transistor, without which computers, the Internet and so much of what makes up the modern world would be impossible. It is clear that he knew that replacing the original vacuum tubes with solid-state devices would be extremely important, although probably not even he imagined the subsequent growth of Silicon Valley. While the first transistor – the so-called “point contact” transistor – was invented by John Bardeen and Walter Brattain in 1947, it was Shockley’s ideas that prevailed and his designs are essentially the ones still in use today. Bardeen, Brattain and Shockley shared the 1956 Nobel prize for their “discovery of the transistor effect” while all three were working at Bell Labs.

In 1955 Shockley left Bell Labs to set up the first semiconductor company in what is now Silicon Valley. He hired people using a combination of intuition, theories of creativity, statistical analysis and psychological tests. Many of those that he employed at Shockley Semiconductor went on to establish major companies of their own or make significant contributions to science and technology. But while Shockley certainly had a knack for identifying creative people, he apparently did not know how to interact with and manage them, which led to the downfall of his company within a couple of years.

When his first wife became ill with cancer, Shockley saw it as another research problem to be solved and contributed substantially to decisions about her treatment. Although Shurkin implies that he was motivated purely by the intellectual challenge and not a deep concern for his wife, this is an extremely negative interpretation of the facts. As a scientist, Shockley must have known that letting emotions interfere does not lead to the best scientific or medical decisions. This type of cold analysis may be hard to understand but it is second

**Shockley ended his life friendless and discredited for his opinions on race and eugenics**

nature for a scientist. Shockley even applied statistical methods to analyse his second wife's love letters!

At the personal level Shockley was a contradictory and perhaps misunderstood man. Some have implied that he walked out on his first wife while she was still fighting cancer. His relationship with his children was rocky, and even when he became terminally ill with cancer, he requested that they not be told. But his second wife found him "romantic" and "charming", and she was his faithful companion until his death in 1989. And although he had serious conflicts with many friends and collaborators, including the co-inventors of the transistor and his employees at Shockley Semiconductor, he could also be generous and helpful to young researchers and students.

Shockley spent the last period of his life worrying about what he thought was his most important work: dysgenics. He believed that within a quarter of a century humanity would become a race of "morons" due to anti-evolutionary forces in modern society. Furthermore, he claimed that there is a clear statistical relationship between IQ and race. He made statistical stud-

ies, publicly debated opponents and even ran for the US Senate based on these ideas. Clearly this became an overriding obsession – but is it not the case that all creative people are a little obsessed? Perhaps the best way to summarize this part of Shockley's life is in the words of Richard Goldsby, a black chemist who called Shockley "a racist but not a bigot" – a racist for believing in the possibility of predicting the behaviour of populations, but not a bigot because he did not despise other races.

Shurkin's book masterfully walks the fine line between presenting Shockley as a purely evil character and legitimizing his more controversial theories. According to Shurkin, the problem with Shockley's later obsession with dysgenics lies not in what IQ measures, but what it does not – such as creativity in the arts and sports – and also in how Shockley's ideas imply a genetic determinism and leave themselves open to misuse.

While *Broken Genius* reveals that Shockley was opinionated, single-minded, obsessive, competitive and sometimes lonely and unhappy, it presents no evidence that he was "bro-

ken". The book also suffers slightly from some scientific errors and a tendency to novelize historical conversations; it would also perhaps benefit from the inclusion of some diagrams and explanation of the trickier scientific terminology. But on the whole it is very readable, and contains many revelations based on Shurkin's exclusive access to roomfuls of previously unseen private documents.

Shurkin manages to humanize and bring some understanding to the contradictory and complex character that was Shockley. Yet ultimately Shockley remains a mystery. How could it be that after all the problems that he had with employees, friends and family he did not realize that something was amiss and that he was not successful? It must be that he was a prime example of Sham's extension of the uncertainty principle that states that "the knowledge of physics and the knowledge of life are conjugate variables".

**Ivan K Schuller** is in the physics department of the University of California, San Diego, e-mail [ischuller@ucsd.edu](mailto:ischuller@ucsd.edu). He has recently co-written, with Adam Smith, a play about the life of Shockley

**NEW Multiple-Hit TDC/Time-Multi-scaler. The new P7889 offers 100 ps time resolution**

The P7889 analyzes the rising or falling edge of input pulses with 100 ps time resolution. Max. input rates to 10 Gbit/s



- NEW!! Time-Interval analysis with 100 ps precision by analyzing both the rising and falling edge !!
- PCI-board (64 bit) with on-board FIFO for continuous ultra fast data transfer
- Continuous histogramming in the PC at more than 30.000.000 stop events/s
- Sweep range from 128ns to 58 years in increments of 6.4 ns
- Multi-hit capable; No Deadtime, No Missed Events, No Double Counting
- WINDOWS 2000/XP based operating software included
- Two on-board ultra-fast discriminators (+/-2V input range)
- 16 Tag-inputs, Options: oven controlled oscillator and Drivers for LabVIEW and LINUX

Other versions with 250 ps to 2 ns time resolution are also available. For four inputs see Model P7888.

For more details and applications visit our site:  
[www.fastcomtec.com](http://www.fastcomtec.com)  
 In the USA call 831-429-5227

**FAST ComTec GmbH**  
 For information contact:  
**FAST ComTec GmbH, Grünwalder Weg 28a**  
**D-82041 Oberhaching/Germany**  
 Web-Page: <http://www.fastcomtec.com>  
 e-mail: [support@fastcomtec.com](mailto:support@fastcomtec.com)  
 Phone: +49-89-665180-50, FAX: +49-89-665180-40



**MAxes™ – Multi-Axis Superconducting Magnet Systems**



- MAxes™ systems are available in 2 or 3-axis geometries.
- The 2-axis systems are offered with 9T/4.5T combination fields and 3T vector fields. These are custom designed for use with 3rd party inserts.
- MAxes™ systems are also available in Optical and Cryogen free designs.

*For details contact:*  
**American Magnetics Inc**  
**112 Flint Road, Oak Ridge, TN 37830**  
**Tel: (865) 482 – 1056; Fax: (865) 482 – 5472**  
**email: [sales@americanmagnetics.com](mailto:sales@americanmagnetics.com)**  
**<http://www.americanmagnetics.com>**